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# FOXTAIL MILLET

## ITS CULTURE AND UTILIZATION IN THE UNITED STATES

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**UTILIZED** in the United States most largely as a catch crop. Adapted to a wide range of soils and climates.

Valued in semiarid regions because its short growing season often enables it to escape periods of drought.

Useful in ridding a field of weeds.

German and Hungarian are the best varieties for humid regions; Kursk and Common for the dry northwestern plains.

Seeding, harvesting, and thrashing millet are easy and simple operations.

The hay of foxtail millet has about the same feeding value as timothy hay.

Injury has resulted when millet hay was used as a continuous ration for horses.

Seed of millet should be ground before feeding.

Not valuable as a constituent of crop rotations.

Remarkably free from plant diseases.

Chinch bugs and army worms are the chief insect enemies.

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## INTRODUCTION.

The name millet is applied to a number of cultivated annual grasses, some of which are used largely as forage crops and others as cereals; most of them, however, are used either for forage or for grain, according to the needs of the growers. In the United States all except the broom-corn millet are used almost exclusively for forage purposes, but in Africa, India, China, Chosen (Korea), Japan, and Russia the millets are grown extensively for human food. In China the broom-corn and foxtail millets are most common, and the grain, after being cleaned and hulled, is crushed and cooked as a porridge, much as certain breakfast foods are used in America. In India, pearl millet, which is grown there under the native name of bajra, is the most important millet. Chosen and Japan produce considerable proso and foxtail millet, and the latter country also devotes a considerable acreage to barnyard millet, which is grown there almost entirely for its seed; but the millet crop is of minor importance in these countries, as it is in Europe, where it is not cultivated extensively except in the Mediterranean region and in Russia. Much proso or broom-corn millet is produced in Russia, especially in the southeastern provinces.

No extended classification of the millets will be given in this bulletin. The main groups, as shown in Table I, are foxtail millet, proso (or broom-corn millet), penicillaria (or pearl millet), barnyard (or Japanese) millet, and ragi (or finger millet). Other forms little

known and of small importance in the United States are Texas millet, or Colorado grass, which is found growing wild in Texas and northern Mexico and is cultivated to a slight extent in Oklahoma, Texas, New Mexico and Colorado; also Shama millet, Kutki millet, Koda millet, and little millet, all of which are grown to some extent as "famine crops" in India, but are not valued in the United States, where better crop plants are available.

TABLE I.—Groups of millets, showing common and botanical names.

[Where there are synonyms, the preferred name is given first, both in the common and botanical names.]

Common names.	Botanical names.	Common names.	Botanical names.
Foxtail millet.....	{ <i>Chactochloa italica</i> (L.) Scribner. <i>Setaria italica</i> Beauv.	Ragi.....	{ <i>Eleusine coracana</i> (L.) Gaertn. Finger millet..... Coracan.....
Italian millet.....		Shama millet.....	
Proso.....	{ <i>Panicum miliaceum</i> L.	Jungle rice.....	
Broom-corn millet.....		Texas millet.....	{ <i>Echinochloa colona</i> (L.) Link. <i>Panicum teranum</i> Buckl.
Hog millet.....		Colorado grass.....	
Russian millet.....		Kutki millet.....	<i>Panicum pilopodium</i> Trin.
Barnyard millet.....	{ <i>Echinochloa frumentacea</i> (Roxb.) Link.	Koda millet.....	<i>Paspalum scorbulatum</i> L.
Japanese millet.....		Little millet.....	<i>Panicum miliare</i> Lamarek.
Sauwa millet.....	{ <i>Panicum frumentaceum</i> Roxb.		
Billion-dollar grass.....			
Pearl millet.....	{ <i>Pennisetum glaucum</i> (L.) R. Br.		
Penicillaria.....			
Cat-tail millet.....	{ <i>Pennisetum typhoides</i> Rich.		
Egyptian millet.....			

In India, Chosen, and certain parts of China the sorghums are referred to as "giant millet" or "tall millet," but this practice happily has not spread to the United States. Of all these millets the foxtail group is most important in the United States, especially for forage, and in the following pages, unless otherwise specified, any reference to millet will mean foxtail millet.

#### DESCRIPTION OF THE FOXTAIL MILLETS.

The foxtail millets are so well known that they hardly need description. They are annual grasses, with slender, erect, or ascending stems, mostly simple, but sometimes branching, from 2½ to 5 feet high under cultivation, and bearing broad, flat leaves. The seeds are borne in a rather dense, cylindrical spike, which, with the persistent bristles attached to the rachis at the base of each spikelet, provides a character by which the foxtail millets differ from all others. In the cultivated foxtail millets there are from one to three bristles to each spikelet. This number is the same in the weed known as green foxtail, supposed by most botanists to be the wild original of the cultivated plant. To the ordinary observer these millets appear more nearly like the yellow foxtail, or "pigeon grass," which is so abundant in stubble fields after the small grains have been harvested. The seeds are inclosed in thin, papery hulls, which

are largely removed in thrashing, leaving free the small convex seed, which is oval or elliptical in outline. The grain or kernel of this seed is inclosed in a box formed by the persistent glumes, or "hulls." Such a fruit is called a caryocist.

The color of the seeds differs with the variety. In some varieties a portion of the seeds are black or dark purple, and in others all are a dull orange, but most of the foxtail millets have pale yellow or straw-colored seeds.

### HISTORY OF MILLET.

Millet is one of the oldest of cultivated crops. Its planting has been mentioned in Chinese records as being part of a religious ceremony carried out by the Chinese Emperor as early as 2700 B. C. Probably native in southern Asia, its culture spread from there westward to Europe at an early date. In 1849 a distribution of millet seed was made by the United States Patent Office,<sup>1</sup> and in 1889 millet had become a rather important crop in the Central States, where it was found better adapted than along the Atlantic coast. By 1899 over 74 per cent of the total acreage of millet was found in the North-Central States. Kansas, with 349,906 acres, led all the States, and produced an average of 1.9 tons of millet hay per acre, against an average of 1.6 tons per acre for the whole United States. According to the Thirteenth Census (1909), Kansas was still first in millet production, the leading States ranking in the following order: Kansas, Missouri, Texas, Nebraska, North Dakota, Tennessee, and Oklahoma. The total production of millet for the United States, which in 1899 amounted to 1,743,887 acres and 2,850,959 tons of hay, decreased in the next 10 years to 1,117,769 acres and 1,546,533 tons of hay. It is quite probable that 90 per cent or more of this acreage is made up of the foxtail millets.

### CLIMATIC ADAPTATIONS OF MILLET.

To succeed well, millet must have warm weather during the growing season. It does not grow well at high altitudes or in other localities where cool weather prevails during the summer months. Notwithstanding this preference for warm weather, millet is grown successfully in our most northern States, especially those in the Great Plains region, because in these States the summers, though short, are hot. Millet, as it matures quickly, can be planted and harvested during these summer months. The long days prevailing in this latitude provide plenty of sunshine, and thus a less period of time is required for maturing the crop. The longer seasoned varieties, like German and Turkestan, can be grown successfully only in the Central or Southern States.

<sup>1</sup> Ann. Rpt. U. S. Comm. Patents, 1849, pt. 2, p. 464-465. 1850.

Millet does best in localities which have a fairly abundant rainfall. Many writers have referred to the millets as drought-resistant crops, and they do have a low water requirement,<sup>1</sup> but they lack the ability to recover after being injured by a period of drought. This ability to recover from drought injury is very pronounced in the sorghums, but the millets succeed in localities subject to drought almost entirely through their ability to escape periods of acute drought on account of their short growing season. Millet is usually one of the first crops to show the effect of a drought, mainly because of its shallow root system.

### SOIL ADAPTATIONS OF MILLET.

A rich, loose, loamy soil is best for millet. Plenty of humus is advantageous, and for this reason millet is often planted on newly turned grass sod. It is a good crop for such situations also, because it seems to aid in disintegrating the sod. Good drainage is essential.

### PLACE OF MILLET IN THE CROPPING SYSTEM.

Millet is grown chiefly as a catch crop and is not important as a constituent in a regular cropping system. Most farmers use it to overcome an expected shortage in their hay supply or to occupy a field which would otherwise be idle on account of the failure of a regular crop or because climatic conditions have prevented the seeding of such a crop. Millet is admirably suited to such use because of its short season of growth and the ease and certainty of obtaining a stand. The plant is also adapted to a wide range both of soils and of climates. Large yields are not obtained either on poor soils or in dry climates, but millet has been found to make a heavier yield under such conditions than most other hay crops. The strongest competitor of millet which has yet been found is Sudan grass, which promises to replace millet in many localities as a catch crop, so that a further decrease in the acreage of millet is to be expected. The quality of Sudan grass hay is superior to that of millet, and its yields under comparable conditions are nearly always larger (Table II), but the growing season is a trifle longer than that required by either Common or Hungarian millet.

Foxtail millet is used to some extent as a soiling crop, but it is not as well suited for this purpose as the sorghums and some of the small grains. Pearl millet is better for use as a green feed than the foxtail millets, because of its larger yield and its ability to make a second growth after being cut down; and both pearl millet and barnyard millet are better silage crops than foxtail millet, because of their larger yields and greater succulence.

<sup>1</sup> Briggs, L. J., and Shantz, H. L. The water requirement of plants. U. S. Dept. Agr., Bur. Plant Indus. Bul. 284, p. 28. 1913.

Relative water requirement of plants. In Jour. Agr. Research, v. 3, no. 1, p. 27. 1914.

Some farmers have made use of millet as a means of ridding a field of weeds. It is very effective for this purpose, on account of the completeness with which its roots occupy the surface soil, the good stands usually obtained, and the vigor of the early growth.

### VARIETIES OF MILLET.

The foxtail group of millets includes ten or more varieties, which are quite distinct in habit of growth and adaptation to different climatic conditions, although all are very closely related botanically.

#### COMMON MILLET.

Common millet has been variously known to the seed trade under the names<sup>1</sup> Early Harvest, Missouri (in part), Dakota (in part), and Italian millet. The date when it was introduced in the United States is not definitely known, but it was one of the first to be grown in this country. It is planted rather extensively over the entire area where millets are grown and makes up a large percentage of the acreage of millets in the Dakotas, Iowa, Nebraska, Kansas, and Oklahoma. In the Southern States German millet is more widely grown than the Common millet. This is very largely due to a longer growing season in these States and the correspondingly larger yield of German millet.

Common millet is fine stemmed and leafy, with a close, compact head, tapering slightly toward the upper end, the lower part of the head usually being looser than the middle and upper part. (Fig. 1.) The individual seed is yellow to straw color, oval to elliptical in outline, and decidedly flattened on one side. Common millet is characterized by a short season of growth, being one of the earliest of the foxtail millets. Tests in the Central States show that under average



Fig. 1.—A single plant of Common millet, showing the characters of the head and the tillers.

<sup>1</sup> Williams, T. A. Millets. U. S. Dept. Agr., Farmers' Bul. 101, p. 10. 1899.



conditions it can be cut 69 days after the date when sown, and in many cases only 50 days are required for it to mature sufficiently for hay. Under favorable conditions it produces 1 to 2 tons of hay

to the acre, and this hay is of first-class quality on account of the slender stems and abundant leaves.

In European countries, especially in France, the Common millet is known quite widely in the seed trade as Green California. Common millet resembles the wild foxtail more closely than any other variety does, and this is good reason for the belief that it was the earliest cultivated type of foxtail millet.

#### GOLD MINE AND CALIFORNIA MILLETS.

These are heavy-yielding varieties, closely related to Common millet. Neither of these varieties is very well known, but the Gold Mine especially deserves a wider utilization and should be planted by farmers

in preference to Common millet in sections where seed of it is available.

#### GERMAN MILLET.

This variety is often sold as "Golden millet," which is about the only trade name, other than German millet, which is used for it at the present time.



FIG. 2.—German millet grown from southern seed at Chillicothe, Tex., in 1909.

Several writers have confused this variety with the Hungarian millet, which came to the United States under the technical name of *Panicum germanicum* and was locally grown for several years as "German millet." German millet, on the other hand, was known in early days as "Bengal grass," but just how this name originated can not be determined. This variety became important first in the central valley of Tennessee, and this locality has continued to be the center of its distribution, many farmers in the vicinity of Franklin, Tenn., making a specialty of the production of German millet seed. In the Southern States it has almost entirely supplanted other foxtail millets and besides is perhaps the principal millet in the Central States, since it is handled by more seedsmen than any other variety. In many places where it is grown, the season is not long enough to mature a seed crop, but it becomes sufficiently mature for hay and makes larger yields than the earlier kinds.

German millet has heavy stems, with broad leaves and a distinctly lobed head, nearly twice the diameter of that of Common millet, but



FIG. 3.—Seeds of Common (1), German (2), and Hungarian (3) millet, showing differences in size, shape, and surface characters. These drawings and the explanation of this figure in the text were furnished by F. H. Hillman, assistant botanist, Seed Laboratory, United States Department of Agriculture.

only slightly longer and not so compact. (Fig. 2.) The individual seeds are smaller and more nearly round in outline than these of Common millet. The surface of the seed coat of German millet is quite rough, with numerous minute elevations, which give it a dull appearance, while Common millet seed has only indistinct transverse ridges, which give it a polished or somewhat shiny appearance. (Fig. 3.) Another difference between the seed of these two varieties lies in the length of the internode between the first and second empty glumes. In German millet this internode is noticeably longer than in Common millet. These differences, which can be plainly discerned with the aid of a small hand lens, provide a ready method of distinguishing German millet from Common millet by an examination of the seed alone, but these characteristics are not sufficient to set these varieties apart from all other varieties of foxtail millet; for example, Golden Wonder millet has seeds which have the same characteristics as those of German millet, and the yellow seeds in Hungarian millet are similar to these of Common millet. Besides these two well-

known millets, imported varieties obtained in China and Manchuria have seed to all appearances identical with that of German millet, but are different in their habit of growth and not so valuable from a forage standpoint. The chief need in the past, however, has been a method of distinguishing between seed of Common and that of German millet, which varieties are often found mixed in commercial seed. The method described is offered as a solution of this problem alone.

A belief is prevalent in the Northern and Central States that after German millet has been grown in these localities for several years it deteriorates or takes on the habit of growth and other characteristics of Common millet. True German millet does not always mature perfectly in the latitude of Iowa and Nebraska, and seed obtained from plantings of the German millet in these States is apt to consist rather largely of the earlier and smaller forms, which resemble Common millet. It is this fact, no doubt, which has given rise to the belief that German millet will not maintain its characteristics when grown continuously for several seasons in the latitude of central Illinois, Iowa, and Nebraska. A comparison of northern-grown with southern-grown seed at Arlington Farm, Va., showed very little difference between the two crops so far as vigor of growth or yield of hay was concerned, but the southern seed produced a more uniform and distinctively German type of plants and had a much smaller admixture of Common millet in it than the crop from northern seed.

German millet is a long-season variety, requiring on the average about 87 days, although under favorable conditions 65 days are sufficient for a hay crop. The hay yield is larger than that of Common millet, but the quality of the hay is not so good.

#### GOLDEN WONDER MILLET.

This variety has a heavy stem and broad leaves very much like those of the German millet, but the head, although distinctly lobed, is more compact, longer, and more slender than that of the latter variety, and the bristles are so short as to be scarcely noticeable. (Fig. 4.) It makes good yields of both forage and seed and for a time was widely advertised as a new millet of very desirable qualities, but it was found to be more easily injured by dry weather than other well-known varieties, and the difficulty of obtaining reliable seed of it has prevented its wide utilization.

#### HUNGARIAN MILLET.

This variety probably originated in Europe, but it was grown in the United States as early as 1830. It did not become popular, however, until after its distribution by the Patent Office in 1854 under the name of *Moha de Hongrie* or *Panicum germanicum*. It

seemed especially well adapted to the rich soils of the Mississippi Valley States and in Iowa came to be known as "Hungarian grass." In other States it was grown under the name of "German millet," probably because of the botanical name which was attached to it by the Patent Office at the time of its introduction and the belief that it came from Germany. This name for Hungarian millet gradually fell into disuse as the other variety, which we now know as German millet, came to be better known.

Many seed dealers and farmers still call the variety "Hungarian grass," and this name is even now used in publications. The use of such a title for this millet is unwarranted and should be discontinued, as it gives rise to confusion with Hungarian brome-grass, an entirely distinct grass which is not at all related to Hungarian millet. By referring to this variety properly as Hungarian millet no confusion can exist.

Hungarian millet is characterized by a small, compact head, which in size and shape resembles that of Common millet very closely. The bristles, however, are usually purple in color, which, with the intermixture of dark-colored seeds, gives the head a darker appearance than that of Common millet. (Fig. 5.) The individual seeds have the same oval or elliptical outline as those of the Common millet, but the color varies from pale yellow to brown, and sometimes very dark purple. Seeds of both colors are found in one head, but the colors are not mixed in a single seed. The season of maturity is about the same as that of Common millet, averaging 69 days in the Central States, but this variety will mature for hay in 54 days when soil and climatic conditions are right. Hungarian millet is not so well adapted to dry climates as the Common millet, and the yield in such localities is apt to be small, but in the Eastern

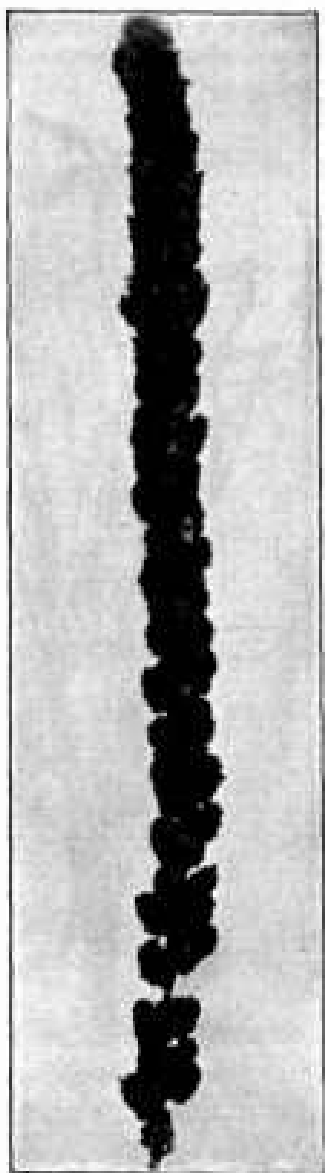


FIG. 4.—A head of Golden Wonder millet: Length, 10 inches; diameter, three-fourths of an inch.

States, where the rainfall is greater, Hungarian millet does well and is widely grown.

The quality of the hay is first class, and chemical analyses seem to indicate a slightly higher protein value for it than for the hays of other millets. The main objection to Hungarian millet in the humid re-

gions has been its tendency to volunteer and persist on the land whenever it was allowed to produce seed.

#### SIBERIAN MILLET.

This variety was obtained from Russia about 1895 and was handled by the seed trade under this name for a number of years before the other two orange-seeded varieties, Kursk and Turkistan, were introduced by the United States Department of Agriculture. Siberian millet is hardy and drought resistant and is suited to Minnesota, the Dakotas, Montana, Wyoming, Colorado, western Nebraska, and western Kansas. In habit of growth and vegetative characters generally it is quite similar to Common millet, but it is a trifle



FIG. 5.—A single plant of Hungarian millet.

more vigorous, and the head is somewhat larger. (Fig. 6.)

The seeds, although similar in shape to those of Common millet in some cases and in others round like those of German millet, are always orange in color, and this character provides an easy method of identifying the variety when seed is purchased. The season of growth is slightly longer than that of Common millet and the yield is somewhat larger, the hay being about the same as that of Common millet in quality and feeding value.

**KURSK MILLET.**

This variety is really a selection from the Siberian millet. It was obtained by the United States Department of Agriculture in 1899, from the Province of Kursk, Russia; whence its name.

Kursk millet has become popular in the western parts of North Dakota and South Dakota and in eastern Montana and Wyoming, where no other variety can be so well depended upon to produce a hay crop in seasons of drought. Farther south and east, where the rainfall is greater and the growing season somewhat longer, the Gold Mine, German, and Turkestan millets will outyield the Kursk considerably.

Kursk millet differs from the parent strain, Siberian millet, in being somewhat less vigorous in growth and having a smaller, more compact head. The head resembles that of Hungarian millet very closely in size and shape and also in having purple-tipped or entirely purple bristles. Kursk millet is much more uniform than the commercial Siberian millet, because it has been the subject of selection during nearly the entire period since its introduction into the United States. This variety is the earliest of all foxtail millets, requiring an average of only 64 days to produce a hay crop, and in many cases it has been ready to cut for hay in 45 days from the date of seeding. It produces large yields of seed, often exceeding those of the proso, or broom-corn millet, which is considered distinctively a grain millet.

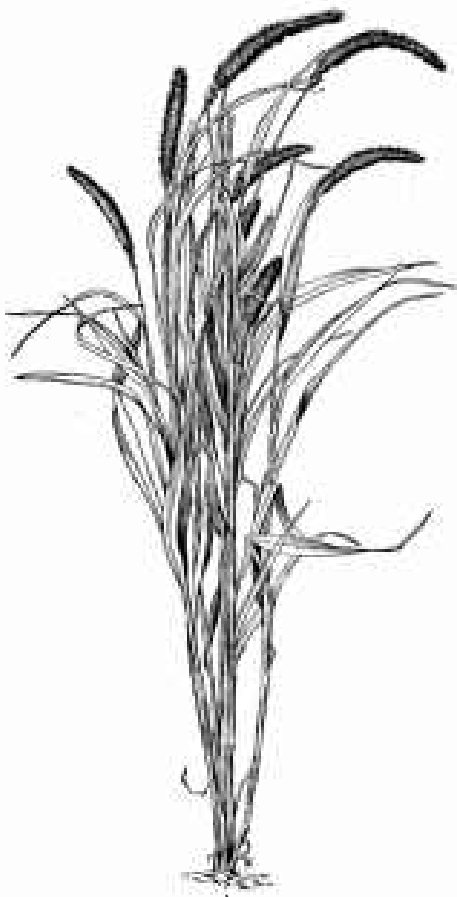


FIG. 6.—A single plant of Siberian millet.

**TURKESTAN MILLET.**

This is a large, coarse-stemmed variety with orange seeds, related to the Siberian millet. It was brought to the United States in 1907 from Russian Turkestan and is not very widely known. It requires

a long growing season, averaging 93 days, and produces a large yield of hay of a rather poor quality. Turkestan millet is adapted only to the Southern States, and especially to Texas.

#### AINO OR JAPANESE MILLET.

The use of the name "Japanese millet" for varieties of foxtail millet and proso, as well as for the barnyard millet, has been the cause of considerable confusion. In the United States the term



FIG. 7.—Characteristic heads of the Aino or "Japanese foxtail" millet, showing lack of uniformity.

"Japanese" is now restricted very generally to the barnyard millet, but the Massachusetts experiment station, about 1889,<sup>1</sup> introduced several varieties of foxtail millet from Japan and also some proso varieties, all of which they tested and distributed under the name "Japanese millet." The proso was distinguished in some cases by calling it "Japanese panicle millet," and a few writers called the foxtail millet "Japanese Common," or "Japanese foxtail millet;" but this was rarely done, and the seed dealers and farmers have been for years at a loss to know just

what to expect under the name Japanese millet. Because of this uncertainty it seems desirable to cease using the term "Japanese" in connection with the foxtail millets which have originated in Japan. Carleton<sup>2</sup> has suggested the name Aino for the Japanese foxtail millet. The Ainos are a prehistoric race of Japan who are supposed to have grown this millet. Among the specimens of Aino millet which were furnished to the United States Department of Agriculture there are some individuals resembling Common millet very closely, while others are more like the Golden Wonder, this

<sup>1</sup> Brooks, W. P., and others. Fertilizers. Mass. (Hatch.) Agr. Exp. Sta. Bul. 18, p. 93, 98. 1892.

<sup>2</sup> Carleton, M. A. Millets. In Bailey, L. H., *Cyclopedia of American Agriculture*, v. 2, p. 472-473. 1907.

variety seeming much less uniform than the others just described. (Fig. 7.) It has been of less value in the United States than other well-known millets and is not likely to gain recognition as a standard variety.

#### COMPARISON OF VARIETIES.

The chief differences in the plant characters of the principal varieties of foxtail millet and their average yields, as indicated by experiment station results for different sections of the United States, are given in Table II in comparison with those of proso and Sudan grass. (Fig. 8.)



FIG. 8.—Kursk millet (on the right) and Sudan grass (on the left) at Redfield, S. Dak., August 10, 1915, 68 days from date of seeding.

Most seed firms now carry in stock only the well-known varieties and list them under their proper varietal names, a practice which can not be too highly commended. The frequency with which the different varieties were listed in the 1916 catalogues of 22 seed firms, selected as representative of all sections of the United States, is as follows:

German.....	21 firms.	Common.....	7 firms.
Hungarian.....	16 firms.	Kursk.....	3 firms.
Siberian.....	10 firms.	Dakota.....	1 firm.

The above list includes all of the foxtail millets advertised by these 22 seed firms, and it will be noted that the Dakota, which is listed by only one firm, is the only variety not generally recognized. In many cases the German millet was listed as "German or Golden," and in several instances Hungarian millet was listed as "Hungarian grass."

There are many other distinct types of foxtail millet besides the varieties which have been described, but no others have exhibited



sufficient promise to warrant their discussion in this bulletin. It is quite possible that better varieties of millet may be developed than the German, Common, Hungarian, or Kursk, but these varieties seem to supply the needs of the farmers at the present time.

Table II.—Plant characters of the principal varieties of foxtail millet and yields of these millets, proso, and Sudan grass for different sections of the United States.

CONTRASTING PLANT CHARACTERS OF THE PRINCIPAL VARIETIES OF FOXTAIL MILLET.

Variety.	Average period of growth.	Size of stem.	Size of head. <sup>a</sup>	Character of head.	Length of bristles. <sup>b</sup>	Color of bristles.	Outline of seed.	Color of seed.
Common.....	Days. 69	Slender.	Medium.	Not lobed.	Long..	Pale yellow.	Oval to elliptical.	Pale yellow.
German.....	87	Stout...	Large...	Distinctly lobed.	..do..	Green to purple.	Round....	Do.
Golden Wonder..	.....	..do.....	..do.....	..do.....	Short.	Pale yellow.	..do.....	Do.
Gold Mine.....	69	Medium.	Medium.	Not lobed.	Long..	..do.....	Oval to elliptical.	Do.
Hungarian.....	69	Slender.	Small...	..do.....	..do..	Purple....	..do.....	(c)
Siberian.....	72	Medium.	Medium.	..do.....	..do..	..do.....	..do.....	Pale orange.
Kursk.....	64	Slender.	Small...	..do.....	Long..	..do.....	..do.....	Do.
Turkestan.....	93	Stout...	Large...	Slightly lobed.	..do..	..do.....	..do.....	Do.

YIELDS OF FOXTAIL MILLETS COMPARED WITH THOSE OF PROSO AND SUDAN GRASS.

Locality.	Length of test.	Hay per acre (tons).							
		Foxtail millets.						Proso.	Sudan grass.
		Common.	German.	Kursk.	Gold Mine.	Hungarian.	Turkestan.		
Great Plains:	Years.								
Northern.....	5	1.66	1.56	1.79	1.36	1.62	1.73	1.38	2.16
Central.....	4	1.71	2.76	2.04	2.30	1.88	2.00	1.27	3.20
Southern.....	5	.....	2.12	1.27	1.62	1.37	2.41	.....	3.74
Northern Mississippi Valley.....	7	1.80	2.15	2.16	.....	2.05	.....	2.04	3.38
Northeastern corn belt.....	7	2.55	43.72	.....	.....	2.80	.....	2.62	3.20
Southeastern States.....	4	.....	3.25	.....	.....	2.42	.....	.....	3.45

<sup>a</sup> In this class the term "small" indicates heads 3 to 4½ inches long and one-half to five-eighths inch in diameter; "medium" indicates heads 4½ to 6 inches long and five-eighths to three-fourths inch in diameter; "large" indicates heads 6 to 9 inches long and 1 to 1½ inches in diameter.

<sup>b</sup> Under this class the term "long" indicates bristles longer than the spikelets, making the heads appear bristly; "short" indicates bristles shorter or about equal in length to the spikelets, so that the head appears smooth.

<sup>c</sup> Some pale yellow, some purple or black.

<sup>d</sup> The high yield of German millet is largely due to the Ohio figures, which give German millet an average yield of 5.1 tons of hay per acre for a period of six years.

### PREPARATION OF THE SEED BED.

The millets are usually sown on spring plowing because of their use as a catch crop, and also on account of their being seeded late in the spring. Spring-plowed is preferable to fall-plowed land, because the operation of plowing usually destroys one crop of weeds. If the plowing is done about two weeks before the time for seeding, another crop of weed seeds will germinate, and this second crop can be killed by cultivating the ground thoroughly with a spike-tooth

harrow or a disk. If a disk is used it should not be set at too great an angle, and it is usually best to lap half way, so that the ground will not be ridged. When fall plowing is used for the seed bed it should always be disked before sowing the millet. A rather fine and firm seed bed is necessary on account of the small size of the seeds, and the ground should be thoroughly leveled and all of the clods crushed, so that there will be no unevenness in the surface to interfere with the mowing machine. Clods are also disadvantageous because they are apt to be gathered up by the rake and remain in the hay, adding considerable useless weight as well as making the hay dusty and dirty.

#### DATE OF SEEDING.

The time of seeding millets permits considerable latitude because of their short season of growth. Millet should not be sown, however,

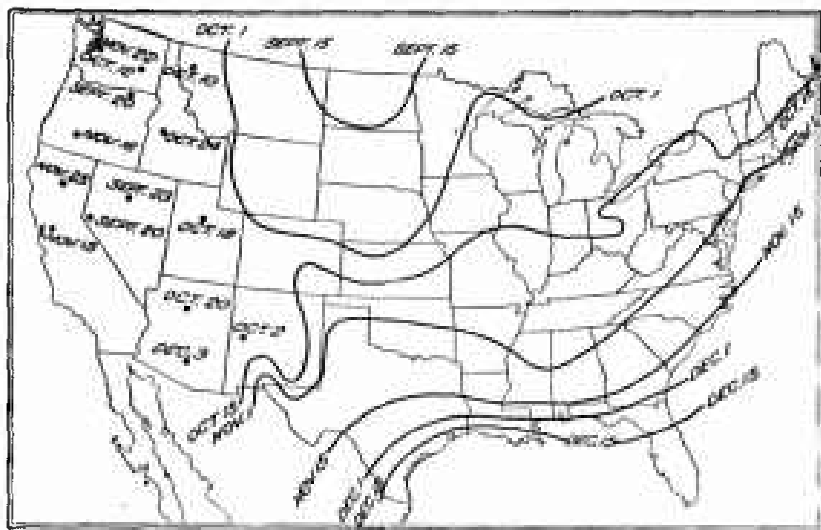


FIG. 9.—Outline map of the United States, showing the average date of the first killing frost in autumn, as indicated by Plate XLX, Weather Bureau Bulletin Q (1906).

until the ground is warm. This means ordinarily about two or three weeks after corn-planting time. In the Central States the preferable time for seeding lies between the last of May and the middle of June. Millet may be sown three weeks earlier than this, however, in case of an early spring. From this date it can be sown with reasonable hope of success at any time up to August 1, and in the Southern States even later. The last seeding should allow for 60 to 70 days of growing season before the normal date of the first killing frost, as indicated on the Weather Bureau chart (fig. 9). By consulting this chart the limits of seeding dates for millet can be readily determined, within reasonable limits, for any part of the United States.

If weather conditions are favorable, a cutting of millet can often be obtained 45 days from the date of seeding. Unfavorable conditions, however, including either a period of drought or unseasonably cool weather, result in an average period of about 70 days for Common, Kursk, and Hungarian millet and 85 days for German millet.

Where the season is long it is often possible to obtain a crop of millet after harvesting small grain, such as oats, barley, or fall wheat. In such cases the ground may be prepared for seeding by disking the stubble. Double cropping of this nature, where both crops are non-legumes, is not a good practice, since the following crop is usually very much reduced. It should be resorted to, therefore, only in cases of evident need of hay.

#### RATE OF SEEDING.

In the more humid areas it is a good practice to seed 25 to 30 pounds (about 2 pecks) of millet per acre. In semiarid districts the rate can be reduced to 10 or 15 pounds per acre, especially if the seed bed is in good condition and a grain drill is used so that the seed will be applied uniformly over the entire surface. It is always well to use sufficient seed, so that weeds will not have an opportunity to obtain a foothold in the millet field. It is much better to have millet plants occupying the soil than to have spaces filled with weeds.

#### METHOD OF SEEDING.

Where the seed bed has been put in good condition and sufficient seed is used, it is easy to obtain a good stand of millet either by using a grain drill or by broadcasting the seed. Care should be taken not to cover the seed too deeply unless the soil is loose and rather dry on the surface. If the surface is slightly rough, as it will be left after using a spike-tooth harrow, a light harrowing, with the teeth of the harrow sloped backward at an angle of 45°, will be sufficient to cover broadcasted seed. Where there is no danger of the surface of the soil baking, a plank or other drag will cover the seed and often insure a better germination than the spike-tooth harrow, because such tools pack the soil around the seed.

It is advised wherever possible to use a grain drill in seeding millet. If difficulty is encountered in adjusting the feed so as to limit properly the quantity of seed planted, this can be remedied either by mixing wheat bran or some other inert matter with the seed or by stopping up alternate holes in the drill. If the seed is mixed with about twice its quantity of cracked wheat and the drill set to sow 3 to 4 pecks of wheat, it will distribute 20 to 25 pounds of the millet seed per acre.

Some writers have advised cultivating the millet with a spring-tooth harrow after it has come through the soil and reached a height

of 3 or 4 inches. This is usually not necessary, however, unless the surface of the ground is baked and hard. Even then there is danger of destroying a considerable percentage of the young plants, and experimental tests have shown that such culture does not often result in increased yields of hay.

#### HARVESTING MILLET FOR HAY.

Millet can be cut for hay with a mower in the same manner as timothy or any other hay crop. It usually stands erect and does not often interfere with the perfect operation of the mower. That which is cut early in the morning, if there is abundant sunshine, can usually be raked into windrows late in the afternoon. It is well, however, to allow it to cure in the swath about one day, after which it can be raked into windrows and allowed to cure sufficiently to be placed in cocks like timothy. After standing a week or more in the cock it can then be stacked or baled. Millet hay sheds water



FIG. 10.—A 230-acre field of millet harvested for seed in western Kansas.

well, and if the cocks are properly built light rains will not do much damage. Canvas covers for the cocks, however, will save a great deal of hay.

If the hay is designed for general use, that is, for feeding both cattle and horses, it should be cut just after blooming. The feeding value of the hay is perhaps greatest from this time until the seed reaches the milk stage.

#### HARVESTING MILLET FOR SEED.

Where a seed crop is the object, millet is best harvested with a grain binder and placed in shocks like bundle grain. It can be allowed to stand in the field until the grain in the head can be rubbed out in the hand. When it has reached this stage of maturity there will be little trouble about the millet spoiling in the bundle unless a period of wet weather is encountered. (Fig. 10.) In climates where

cloudy, wet weather is apt to prevail during the harvesting season it is better to cut the millet with a mower and handle it as one would a hay crop. This method, however, wastes considerable of the seed, which shatters out when the crop is being placed in the cock and later when hauled to the stack. Cutting with a grain binder prevents a great deal of this loss and also leaves the millet in better shape to be thrashed, so that the task of thrashing can be accomplished more satisfactorily.

### THRASHING MILLET.

Millet can be thrashed with an ordinary grain separator, the only change necessary being a substitution of screens capable of handling the small seed. Clover screens are often used for millet. Where the crop has been harvested with a binder the concaves do not need to be set very close to the cylinder, as the seed shells out very easily. Under such conditions the straw will not be broken up badly, and little trash or inert matter will be present in the seed. The air blast should be regulated so that only the immature, nongerminable seeds will be blown out with the chaff.

### FEEDING VALUE OF MILLET HAY.

Millet hay is usually considered inferior to that of timothy and some of the other tame grasses. This is due to some extent to its lesser palatability, but also to the injurious effect which it often has on horses when fed continuously as the sole roughage. The hay is slightly laxative and also acts as a diuretic, its effect on the kidneys being particularly noticeable in horses.

The hay can be fed without danger to cattle and sheep. As a feed for dairy cows it is valued by some, although others say it produces fat and decreases the milk flow. Chemical analyses show that millet compares favorably with timothy and Johnson grass in the actual amount of the different food elements which it contains. Table III presents the average of a number of analyses, compiled by Mr. G. L. Bidwell, of the Bureau of Chemistry, United States Department of Agriculture.

TABLE III.—*Food elements in the dry matter of millet, timothy, and Johnson grass.*

Crop.	Number of analyses.	Average constituents (per cent).				
		Ash.	Crude protein.	Fiber.	Nitrogen-free extract.	Ether extract.
Millet.....	40	8.82	9.85	30.08	48.22	3.03
Timothy.....	104	6.23	8.19	32.53	49.87	3.18
Johnson grass.....	40	7.71	8.80	32.72	47.77	3.00

The digestibility of these different elements is about the same in millet as in timothy, and somewhat lower in Johnson grass than in either of the others.

The Connecticut (Storrs) experiment station found Hungarian millet inferior to red-clover hay when it was fed to dairy cows. Both the quantity of milk and the percentage of butter fat increased by a change from millet to red-clover hay.

The general opinion among feeders is that millet hay is somewhat more effective than prairie hay as a roughage for growing stock, especially cattle and sheep. Very few, however, consider it equal to alfalfa or clover hay.

#### INJURIOUS EFFECT OF MILLET ON HORSES.

The injurious effect of a continuous ration of millet hay on horses was studied by Dr. T. D. Hinebaugh,<sup>1</sup> of the North Dakota experiment station, in 1896. He found that when a horse was fed millet exclusively as a roughage for any considerable period a general debility was evident, and this later developed into a softening of the bones and inability to stand. Cessation of the use of the millet hay resulted almost immediately in improvement in the condition of the horse, while a resumption of the millet feeding was followed by a relapse. Dr. E. F. Ladd later found that the injury was caused by a glucosid called setarian, which is present in millet hay whether mature or not.

The belief is general that millet cut before seed has formed is much less injurious to horses, but the North Dakota experiments showed that cutting it before the seed has formed will not prevent injury. This injurious effect is noted (1) as producing an increased action of the kidneys; (2) in causing lameness and swelling of the joints; (3) in producing infusion of blood into the joints; and (4) in destroying the texture of the bone, rendering it softer and less tenacious, so that the ligaments are often torn loose from the bone and the bones themselves break easily. These results were verified by a post-mortem examination of two horses which had been fed millet as their sole roughage and can scarcely be subject to doubt, even though many newspaper articles deny that there is any danger in feeding millet hay to horses. When fed sparingly in connection with other kinds of hay, there is little danger of injury, and it can be used in this way with good effect to augment a roughage ration for horses.

#### GROWING MILLETS IN MIXTURES WITH LEGUMES.

MILLETS are sometimes used in mixtures with cowpeas or soy beans as a soiling or hay crop for dairy cows. This practice is more often

<sup>1</sup> Hinebaugh, T. D. Feeding of millet to horses. N. Dak. Agr. Exp. Sta. Bull. 26, p. 89-105. 1896.

followed in the Southern States than in those farther north. If one expects to utilize a mixture of this kind, care must be used in selecting the varieties of millet and cowpeas or soy beans, so that the two constituents of the mixture will arrive at maturity at about the same time. If Common millet is used, some very early variety of cowpeas or soy beans must be seeded in connection with it. With the German millet, varieties like the Whippoorwill, New Era, or Clay cowpeas or the Peking or Wilson soy beans succeed quite well in mixed seedings.

Mixtures of millet and legumes produce a hay of better quality than the millet alone, so far as feeding value is concerned, since the legumes add the necessary protein element to the hay. The millet is beneficial to the legumes as a hay crop, because of its erect habit of growth and the ease with which it can be cured. Such mixtures are not always successful, because the millet is apt to start growth more promptly and crowd out the legumes either by shading them too much or by appropriating too large a percentage of the available soil moisture.

Another difficulty experienced is in obtaining a proper mixture. One way to accomplish this is to stop each alternate hole in the grain drill and seed the legumes first. Then seed the millet by running the drill in the same tracks, using only those holes which were previously stopped. It will provide for more nearly equal growth if there is a delay of four or five days between the times of seeding the legumes and the millet. Some provision for raising the hoes or disks of the drill which are not working must be made, so that the legume seed which has sprouted will not be disturbed. This method, of course, necessitates going over the field twice with the drill. Where the seed is mixed before it is placed in the drill, this double seeding is not necessary, but it is almost impossible to maintain a proper mixture of the seed as it leaves the feed in the drill. Most of the mixtures are broadcasted by hand and covered with a harrow. If labor is scarce and the time for seeding is short, this latter method is to be recommended. In the more humid districts 12 to 15 pounds of millet with 45 to 60 pounds of cowpea or soy-bean seed is advised. Where the rainfall is less abundant, in the semiarid district, 8 to 10 pounds of millet with 40 to 45 pounds of cowpea or soy-bean seed is better.

Owing to the difficulties of seeding and the fact that oftentimes a proper proportion of the legumes is not obtained, it is doubtful whether seeding in mixtures will ever become popular. Experiments have shown that better yields are obtained in most cases where the two crops are grown separately. They can be handled to better advantage in this way; and, after harvesting, the two crops can be

fed alternately or mixed at feeding time, and thus the advantage, so far as the quality of the feed is concerned, will be as fully accomplished as if the millet had been grown in mixtures with the legumes.

### MILLET AS A GRAIN CROP.

Foxtail millet has never been utilized to any great extent as a grain crop in the United States. In China and certain other parts of Asia, as was stated in the introduction, it is used more or less as human food. So long as wheat can be produced in the United States as abundantly and cheaply as at present little millet will be grown for human food. One method which seems most attractive at the present time is the utilization of the decorticated or hulled grain of the millets as a breakfast food. Preliminary tests have shown it to be quite palatable when properly prepared, and it should prove a strong competitor of the breakfast foods now on the market.

Proso, or broom-corn millet, is more distinctively a grain millet, and it has been used to some extent in North Dakota and South Dakota as a grain crop. Trials of the grain of broom-corn millet and the foxtail millets in rations for hogs and beef cattle indicate that it is much less valuable than corn for this purpose and does not equal barley as a flesh producer. The South Dakota Agricultural Experiment Station found that it took about 8 per cent more millet than barley to produce a pound of gain, and on this basis it would be about 16 per cent less efficient than corn as a hog feed. The meat produced by millet contained a greater percentage of lean than that produced by other feeds, and the fat was softer. For feeding steers it required 37 per cent more millet than corn to produce a pound of gain, 29 per cent more than oats, and 22 per cent more than spelt.

Yields of 15 to 30 bushels of grain are obtained under favorable conditions, and although broom-corn millet is considered a grain millet, Kursk millet has consistently outyielded it when comparative tests were carried on to determine grain yields. The seed of the Kursk millet, however, is smaller than that of broom-corn millet and less valuable when fed whole to stock, as it is more apt to pass through the animal undigested. When properly fed, however, the seed of foxtail millet gives results practically equal to those obtained with proso, so that the South Dakota results may be considered as an index to its value as grain. In feeding millet grain it is always well to crush or grind it before giving it to the animal. Mixing it with wheat bran or adding to the ration some concentrate like cottonseed meal or linseed cake, which are high in protein and fat, is recommended.

A large quantity of millet seed is used as chicken feed and in prepared bird foods. For such purposes both the foxtail millet and the



proso seed can be used without grinding. An analysis<sup>1</sup> of one well-known bird-seed preparation showed it to contain—

	Ounces.
Canary seed.....	4.75
Hemp (largely hulls).....	2.50
Rape seed.....	.50
Common millet seed.....	7.75
Cuttle bone.....	.50
Total.....	16.00

For canaries and other small birds the foxtail millet is used a great deal, and, as in the above sample, where it is the cheapest constituent, it often makes up about half the weight of the sample. For larger birds the proso seed is commonly used, and in some cases it is substituted for the canary seed, to which it bears a slight resemblance if light colored.

The legal weight per bushel for seed of the foxtail millets is 50 pounds in most States, and well-cleaned seed of most varieties will be found to weigh between 45 and 50 pounds to the bushel very consistently.

#### PASTURING MILLET.

Most of the millets are not suitable for pasture purposes, and this is especially true of the foxtail varieties. The main difficulty lies in the shallow root system, which allows the plants to be pulled up very easily. Another weakness of millet as a pasture plant is that it does not renew its growth very quickly after being cropped off. The Common and Hungarian varieties are best in this respect. It is not to be recommended, therefore, as a pasture plant except to supply a limited amount of pasture in an emergency for young stock, like calves or colts, and even for such animals some other annual hay plant might be used to much better advantage. Winter rye or spring oats will furnish more and better pasture than millet.

#### VALUE OF MILLET IN ROTATIONS.

The millets, being annual crops, can be used in almost any rotation where a spring-sown crop is required. Most farmers who have grown millet believe it to be rather exhaustive of soil fertility. It has been proved that no more plant food is removed from the soil by millet than by other crops where a like tonnage of hay is produced. It is likely that the effect on the following crop comes through the depletion of available plant food and moisture in the upper 6 or 8 inches of soil. Other crops with a deeper root system gather their plant food and moisture from greater depths, and thus the plant food required for the following crop is not so completely exhausted

<sup>1</sup> Crozier, A. A. Millet. Mich. Agr. Exp. Sta. Bul. 117, p. 20. 1904.

from that portion of the soil in which the new crop must begin its growth. Another reason why millet might have a bad effect on the following crop is the small quantity of vegetable matter left on the soil by a crop of millet which has been harvested for hay. The stubble which is left after mowing is exceedingly short, and all of the trash is raked up, so that little vegetable matter of any kind is left for the production of humus when the stubble is plowed under. Considering all of these points, it is quite likely that there is some foundation for the belief that a crop following millet will be less than one which follows a crop of small grain or corn, even though these other crops are not classed as soil builders. Millet, therefore, can not be recommended as a regular constituent in any rotation.

#### USE OF FERTILIZERS FOR MILLET.

It has been found by a number of tests that the use of fertilizers on ground which is to be seeded with millet is not advisable. Of the three principal elements of commercial fertilizers, nitrate of soda is more likely to show a profit than phosphate or potash. This, of course, will depend to some extent upon the nature of the soil itself. Rather complete fertilizer tests were carried on by the New Jersey Agricultural Experiment Station in 1888.<sup>1</sup> These tests included separate applications of nitrate of soda, superphosphate, and muriate of potash at the rate of 150 pounds, 350 pounds, and 150 pounds, respectively. These three fertilizer elements were also used in combinations of two and three. Land plaster was also tried, at the rate of 400 pounds per acre, and barnyard manure, at the rate of twenty 2-horse loads per acre. None of these applications showed a profit except the nitrate of soda, and the net gain in that case amounted to only 73 cents per acre.

The Tennessee Agricultural Experiment Station,<sup>2</sup> on the contrary, obtained a decided increase in hay yields with nitrate of soda and also with acid phosphate when applied to millet fields on silt loam and sandy-loam soils. Muriate of potash used in connection with nitrate of soda and acid phosphate gave an increase in yield on some soils, but not on others. In all cases it appeared less valuable than the two other elements. Where nitrate of soda was used in conjunction with acid phosphate, 160 pounds per acre of the former and 150 to 300 pounds of the latter fertilizer were used with profit. The acid phosphate and the muriate of potash were harrowed into the soil before seeding, while the nitrate of soda was applied as a top-dressing at the rate of 160 pounds per acre as soon as the millet came up.

<sup>1</sup> Arnold, A. P. Field experiments. In Ann. Rpt. N. J. Agr. Exp. Sta. 1888, p. 83-89. 1889.

<sup>2</sup> Tenn. Agr. Exp. Sta., Report of cooperative and extension work, 1907-8, p. 22-24. 1908.

The Rhode Island Agricultural Experiment Station<sup>1</sup> states that "this [German] millet is usually injured by heavy applications of lime, even upon acid soil." In the experiment described, however, the application of a ton of slaked lime per acre just before the crop was planted resulted in an increase in yield in every case but one. Phosphate fertilizers gave an increased yield in every case, but the percentage of increase due to the phosphate was greater on the unlimed than on the limed plats.

These conflicting results indicate that the profitableness of using fertilizer for millet depends largely on the nature and needs of the soil, and those needs must be determined separately for each individual case. Ordinarily fertilizers should be applied to other crops in the rotation rather than to the millet.

### DISEASES OF MILLET.

The foxtail millets are less subject to destructive plant diseases than most other crops. There is in some cases a slight tendency to smut, but this trouble does not affect the hay crop seriously, and in the semiarid regions the extent of the damage to the crop of grain is very slight. The common smut of the foxtail millets is technically known as *Ustilago crameri* Körn, and it can be controlled by treating the seed with hot water or formalin. If the hot-water treatment is employed, the smutted seed should first be floated off by throwing the seed loose into cold or lukewarm water. The seed should then be placed in a porous bag or woven basket and dipped in water at a temperature of 110° to 120° F. to warm the seed, after which it is immersed for 10 minutes in water at a temperature of 132° or 133° F. The temperature of the water should be retained during the 10 minutes at not less than 130° F. After treatment the seed is dried quickly, to prevent its sprouting.

The formalin treatment is much simpler and is gradually superseding the hot-water treatment for smuts. It consists in dipping the seed in a solution containing 1 pint of formalin to 30 gallons of water. The seed may be put in sacks or baskets containing one-half to 1 bushel each and immersed in a barrel of the formalin solution for about 10 minutes. When taken out, the sacks of wet seed are suspended, so that they will drain, or the seed is placed in piles and covered for two hours, after which it is dried as rapidly as possible to prevent it from sprouting. Shoveling the seed over frequently will accelerate the drying process.

<sup>1</sup> Wheeler, H. J., and Adams, G. E. Continual tests of nine different phosphates. R. I. Agr. Exp. Sta. Bul. 118, p. 71-72. 1907.

INSECT ENEMIES OF MILLET.<sup>1</sup>

The most destructive insect enemies of millet are the chinch bug and army worm. These insects are very fond of the foxtail millets, and when abundant in any locality their injuries to the millet crop are frequently very great. Millet is therefore sometimes used as a trap crop for the protection of fields of corn or small grains, but this method is not often successful where chinch bugs occur in large numbers, and therefore is not recommended. A successful way of protecting fields of millet from chinch-bug invasion is by means of a deep furrow plowed around the edges of the field to be protected, running the land side of the plow toward the field. In dry weather the sides of the furrow thus made can be rendered so steep and the earth so evenly pulverized that the chinch bugs can not crawl out of it. In showery weather the bottom of the furrow can be smoothed with a shovel, thus making it easier for the bugs to follow along the bottom than to climb the sides of the ditch. If holes with perpendicular sides are then dug across the bottom of the ditch at intervals of 30 to 40 feet, the chinch bugs will fall into them and can be disposed of easily by the application of kerosene oil.

The army worm also may be prevented from reaching fields of millet by the use of precisely similar furrows in which the caterpillars may be crushed by dragging a chunk or log back and forth in the furrow.

When a large brood of grasshoppers hatches in a locality they are likely to do considerable damage before they arrive at maturity. The most effective way of destroying them is by scattering poisoned bran about the edge of the field. This grasshopper poison is made up of the following ingredients:

Bran.....	pounds..	25
Paris green or white arsenic.....	pound..	1
Low-grade molasses.....	quarts..	2
Oranges or lemons.....		3
Water.....	gallons..	3½

Mix the bran and Paris green or arsenic thoroughly in a tub while dry. Squeeze the juice of the oranges or lemons into the water, chop the remaining pulp and the peel to fine bits, and add them to the water. Dissolve the molasses in the water and wet the bran and poison with the mixture, stirring at the same time, so as to dampen the mash thoroughly. This bait when flavored with oranges or lemons was found to be much more attractive to the grasshoppers than that prepared without fruit of any kind.

<sup>1</sup> This discussion of insects and methods for their control has been contributed by the Bureau of Entomology.

The poisoned bran should be scattered, at intervals of several days, about the field in open places where the insects are most abundant, so that there will be fresh bran for the grasshoppers to feed upon until their numbers are reduced sufficiently to save the crop. Only community action can make this war on the grasshoppers effective, as they will migrate from a field on which the crop has been destroyed to fresh fields as soon as their supply of food becomes scarce.

Other insects which have been known to attack millet, but which are not of any great importance, are flea beetles, wireworms, and the southern corn rootworm.